

Chapter 3

Vascular Access

Introduction

Obtaining vascular access in infants and children can be difficult even under optimal conditions. Attempting emergent access in a shocky, struggling infant is even more challenging.

Routine Access

Careful consideration should be given to the routine sites for peripheral intravenous (IV) access before more emergent techniques are employed. Often access can be obtained via peripheral veins on the back of the hand, in the antecubital space, or in the great saphenous vein at the ankle. Common pitfalls in pediatric IV placement include attempting placement without sufficient assistance to restrain the child, especially the involved extremity, and an inexperienced provider using a catheter that is too small. Infants can tolerate 22- and 24-gauge IV catheters, while toddlers' and young children's veins can accommodate 20- and 22-gauge catheters. As older children's size approaches adult size, they are more likely to tolerate 16- and 18-gauge catheters.

When timely attempts at routine peripheral access fail, consideration should be given to either external jugular vein cannulation or intraosseous (IO) needle placement. In an emergency, these alternatives, especially IO needle placement, should be considered within 2 minutes.

External Jugular Vein Cannulation

The external jugular vein is a large peripheral vein that is relatively easy to cannulate, and it offers quick access to central circulation. It lies superficially along the lateral aspect of the neck, extending from the angle of the mandible downward until it pierces the deep fascia of the neck, just above the middle of the clavicle, ending in the subclavian vein. Because it is a very superficial vein, it tends to "roll" and be positional. Slight movement of the head may affect the flow of fluid.

- **Technique**

- Position the patient in the supine, head-down position and rotate the head to the opposite side
 - ▶ Infants can be positioned at the edge of an examination table and their heads lowered (this is a 3-person technique)
- Prepare the skin aseptically
- Apply digital pressure to the vein distally (just above the clavicle), which will distend the vein (applying slight traction with the thumb at the proximal portion of the vein may prevent the vein from rolling)
- Insert an IV catheter with an empty syringe attached into the middle of the vein, remembering its superficial position
- Aspirate with the syringe after puncturing the skin and, immediately upon seeing a flashback, thread the catheter; stop if you meet resistance
- Secure well
- Keeping the head in a neutral position seems to optimize IV flow

- **Complications**

- Trauma patients with potential cervical spine injuries should be approached with caution
- Reduce the risk of air embolism by using a syringe attached to the angiocatheter during insertion
- Pneumothorax is a remote possibility

Intraosseous Needle Placement

IO needle placement can provide emergency vascular access on a child when peripheral access is unobtainable. This technique can be used on patients of all ages. The bone marrow, a noncollapsible structure with a rich network of arteries and veins, can provide a rapid and reliable route for administering crystalloids, blood products, vasopressors, and drugs into the central circulation. Although products specifically designed for IO access are ideal, a stylet needle used for bone marrow aspiration or a large adult spinal needle can be used in an emergency.

- **Technique**

- Common insertion sites (Figure 3-1):
 - ▶ Tibial plateau: the flat medial surface of the proximal tibia 1–2 cm below the tibial tuberosity

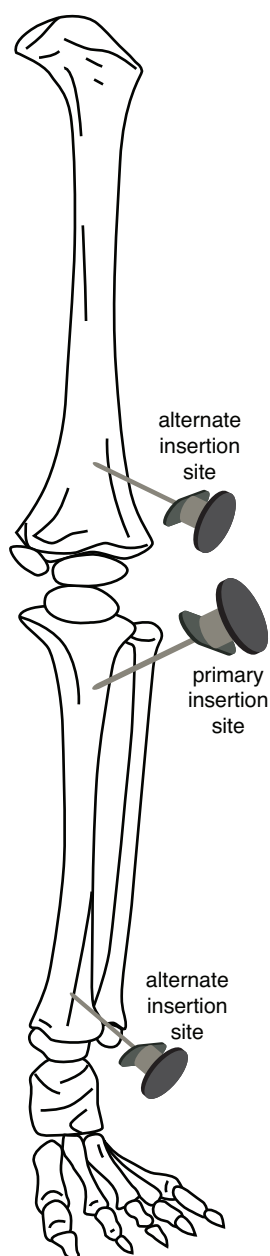


Figure 3-1. Preferred sites for intraosseous needle placement.

- ▶ Distal femur: 3 cm above the superior aspect of the patella
- ▶ Distal tibia, radius, and ulna; iliac crests; or sternum
- Apply rigid support to the posterior aspect of the insertion site (do not place your hand directly posterior to where needle will be driven)
- Using an aseptic technique, prepare the selected site with Chloraprep (Cardinal Health, Dublin, Ohio) or Betadine (Purdue Pharma LP, Stamford, Conn)
- In an awake patient, inject the skin with lidocaine for local anesthesia
- If using a product designed specifically for IO access, follow the manufacturer's directions
- If using a bone marrow aspiration needle, after penetrating the skin, direct the IO needle at a slight angle (10° – 15°) caudad (in the femur, angle it cephalad) and apply pressure with a to-and-fro rotary motion
 - ▶ As the needle passes from the cortex of the bone into the marrow, resistance will diminish
 - ▶ Remove the stylet and check needle placement by attaching tubing connected to a saline-filled, 10-cc syringe
 - ▶ Bone marrow can be aspirated and fluid should be easily infused
- Observe for fluid infiltration of the calf; if this occurs, repeat the attempt in the opposite leg
- Secure the tubing to the leg with tape and gauze
- Minimize needle manipulation by attaching syringes or a stopcock to the tubing
- Maintain vigilant care and observation of the insertion site; accidental dislodgement of an IO needle will manifest as fluid extravasation into a swollen calf, or the needle will be mobile at the site
- Once the emergent condition is under control and the child has been resuscitated, attempt peripheral or central intravenous access, as IO lines are notoriously short lived (minutes to hours)
- **Complications**
 - Osteomyelitis
 - Fracture

- Necrosis of the epiphyseal plate
- Extravasation
- Compartment syndrome

Percutaneous Central Venous Lines

Percutaneous central venous lines are required when peripheral venous access is either unavailable or insufficient. Central venous lines last longer (days to weeks), allow for central venous pressure monitoring and phlebotomy, and can safely tolerate vasoactive medication drips and hyperosmolar therapies. The preferred site for central vein access in children is the femoral vein. It is easier and safer to access than the internal jugular or subclavian veins, especially during resuscitation. Unlike in adults, there are no pediatric data suggesting a higher risk of infection at the femoral site. Lines placed under suboptimal conditions should be changed when the patient's condition warrants. Like adults, debilitated pediatric patients with indwelling central lines are at risk for catheter-related bloodstream infections and thrombosis. Fortunately, the risk of deep venous thrombosis is lower in children than in adults. The standard aseptic Seldinger technique is used for line placement.

Arterial Lines

Arterial lines can be placed for minute-to-minute arterial blood pressure measurement, frequent arterial blood gas sampling, or continuous cerebral perfusion pressure measurement in cases of traumatic head injury (Table 3-1).

Table 3-1. Pediatric Central and Arterial Venous Line Sizes

Age/Size of Child	Central Line Sizes	Arterial Line Sizes
Infants < 5 kg	3 Fr 5–8 cm single lumen; 4 Fr 8 cm double lumen; OR 20-gauge 12 cm pediatric jugular vein kit	24-gauge IV catheter; 2.5 Fr 2.5 cm for peripheral (radial) access; 2.5 Fr 5 cm for central (femoral) access
Larger infants/ toddlers < 10 kg	4 Fr 8 cm double lumen; OR 20-gauge 12 cm pediatric jugular vein kit	22- or 24-gauge IV catheter 2.5 Fr 2.5 cm for peripheral (radial) access; 2.5 Fr 5 cm for central (femoral) access; OR 20-gauge 12 cm pediatric jugular vein kit for femoral access
Preschool children < 20–25 kg	5 Fr 8–12 cm double or triple lumen	20- or 22-gauge IV catheter
Older children	7 Fr adult triple lumen line	20- or 22-gauge IV catheter

Fr: french size

IV: intravenous